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DYNAMIC TEST FACILITY FOR AN/ALQ-119 LOW-VOLTAGE POWER SUPPLIES--ETC(U)
SEP 79 J R WHITE F09603-78-G-4125-0002
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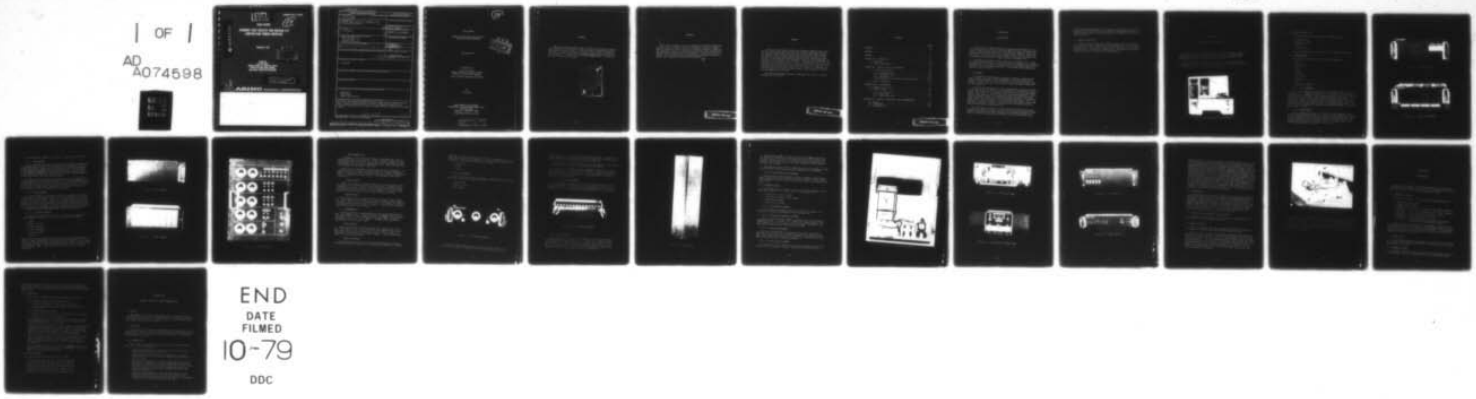

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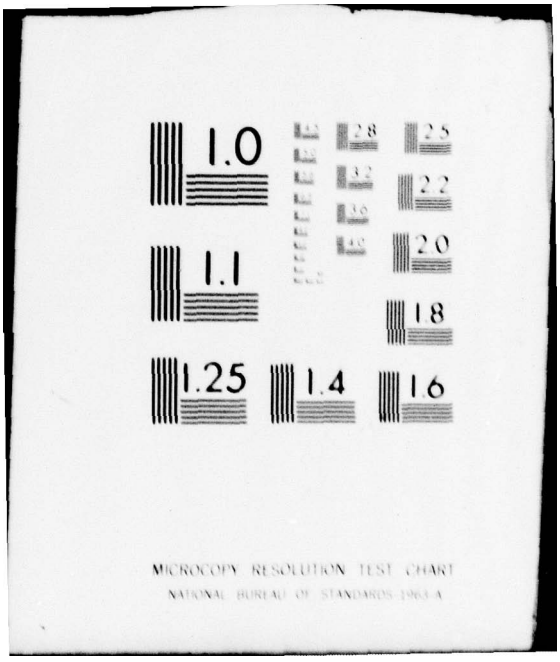
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Publication 1552-11-1-2012

FINAL REPORT

DYNAMIC TEST FACILITY FOR AN/ALQ-119 LOW-VOLTAGE POWER SUPPLIES

September 1979

Prepared for
U.S. AIR FORCE
WARNER ROBINS AIR LOGISTICS CENTER
ROBINS AIR FORCE BASE, GEORGIA
under Contract F09603-78-G-4125-0002

ARINC RESEARCH CORPORATION

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by

J.R. White

ARINC Research Corporation
a Subsidiary of Aeronautical Radio, Inc.
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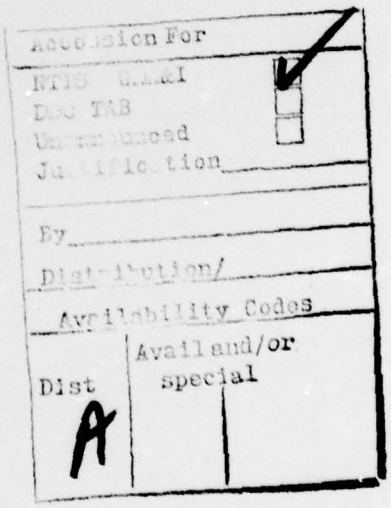
Annapolis, Maryland 21401

Publication 1552-11-1-2012

FOREWORD

This report describes ARINC Research efforts under Contract F09603-78-G-4125-0002 to design, develop, install, and test an operational Dynamic Test Facility at Warner Robins Air Logistics Center (WR-ALC), Robins Air Force Base, Georgia. The work was accomplished under the technical direction of Messrs. J. Ringley and D. Williams of MMRRE and Mr. J. Defore of TRC, all of whom are with WR-ALC.



ABSTRACT

This report describes the work performed for the Warner Robins Air Logistics Center (WR-ALC), Robins Air Force Base, Georgia, to design, develop, fabricate, install, and test a Dynamic Test Facility (DTF) for the depot-level testing of low-voltage power supplies of the AN/ALQ-119 ECM pod under full-operational-load conditions. The DTF consists of a Dynamic Test Set and supporting documentation, including the operating manual, test procedures, and engineering drawings.

SUMMARY

Under Air Force Contract F09603-78-G-4125-0002, ARINC Research Corporation designed, developed, installed, and tested an operational Dynamic Test Facility (DTF) at the Technical Repair Center (TRC), Warner Robins Air Logistics Center (WR-ALC), Robins Air Force Base, Georgia. The DTF provides for the full-operational-load testing of the low-voltage power supplies (P/N 624R629G01 or P/N 634R149G01), which are interchangeable subassemblies of the AN/ALQ-119(V) Electronic Countermeasures (ECM) pod. The DTF consists of the Dynamic Test Set (DTS), including 1-½ racks of controls, load banks and coolers, and an air-cooled metal cold plate bench for installation of the power supply during test or checkout. In addition, supporting documents such as an operating manual, test procedures, and engineering drawings were provided.

The DTS was developed, delivered, installed, and tested on location at WR-ALC on 12 July 1979.

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CHAPTER ONE

INTRODUCTION

Under Air Force Contract F09603-78-G-4125-0002, ARINC Research Corporation developed a Dynamic Test Facility (DTF) for use in the repair and testing of AN/ALQ-119(V) Electronic Countermeasures (ECM) pod low-voltage power supplies. Warner Robins Air Logistics Center (WR-ALC), Robins Air Force Base, Georgia, was the technical monitor for this effort, which was performed during the period 1 October 1978 to 30 September 1979.

The Dynamic Test Facility (DTF) consists of a Dynamic Test Set (DTS) and supporting documentation, including an operating manual, test procedures, equipment test plan, service engineering reports, nonstandard parts lists and approvals, and engineering drawings. All hardware and documentation items have been delivered.

1.1 BACKGROUND

The AN/ALQ-119 ECM equipment pod requires multiple, regulated power supply voltages for proper system performance. The low-voltage power supplies (P/N 624R629G01 or P/N 634R149G01) were designed to furnish these multiple outputs. They use sophisticated circuitry to ensure proper and precise regulation.

The failure or malfunction of these power supplies cannot be corrected at the field level; most repairs are accomplished in the Technology Repair Center (TRC) at WR-ALC. The detection and location of the internal faults require the services of skilled technicians using specialized test fixtures. However, some faults may not be detected because the present bench test cannot adequately simulate the dynamic load characteristics or fluctuating power sources that are typical of the operational environment. Thus it is possible to inspect and accept a defective power supply (after repair) and experience a premature failure or malfunction after installation in the ECM pod during test or operational use.

The requirement for and the initial design of the DTS resulted from two previous contractual efforts (directed by WR-ALC and conducted by ARINC Research Corporation) that were concerned with performing analyses and tests to improve the operational reliability of these two specific types

of low-voltage power supplies. The general conclusion was that the power supplies were not being subjected to realistic operational load tests during checkout because of the nonavailability of required cooling air at the TRC activity.

1.2 REPORT ORGANIZATION

Chapter One has presented an overview of the project and background. Chapter Two describes in more detail the component parts of the Dynamic Test Facility. A description of supporting documentation and contractual items delivered is presented in Chapter Three; and Chapter Four presents pertinent results, conclusions, and recommendations.

CHAPTER TWO

DYNAMIC TEST SET DESCRIPTION

The Dynamic Test Set (DTS) developed under this contract is shown in Figure 2-1. This DTS is used for testing and repair of interchangeable low-voltage power supplies (P/N 624R629G01 and P/N 634R149G01) of the AN/ALQ-119(V) Electronic Countermeasures (ECM) pod.

The DTS consists of 1-½ racks of equipment; a forced-air-cooled bench for mounting the power supply undergoing test; and associated accessories consisting of test jigs, fixtures, and test cables.

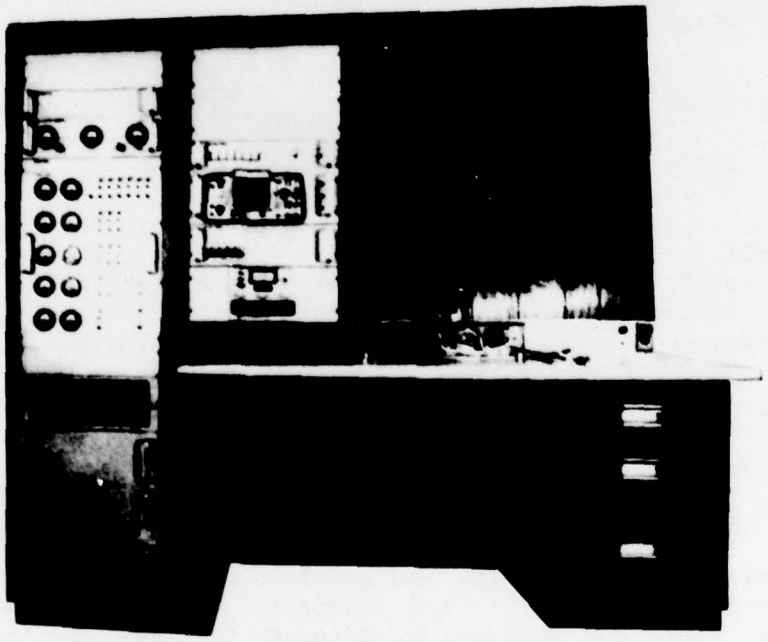

Figure 2-1. OVERALL VIEW WITH ACCESSORIES

2.1 DETAILED DESCRIPTION

The DTC consists of the following four assembly groups:

- Equipment rack
- Equipment cabinet
- Test bench
- Accessory group

These equipment groups are discussed in the following subsections.

2.1.1 Equipment Rack

The equipment rack consists of the following assemblies:

- Relay
- Power supply
- Card
- Blower
- Load panel
- Line monitor
- Calibration
- Load
- Transformer chassis

2.1.1.1 Relay Assembly

The relay assembly (see Figure 2-2) is the power-switching and junction box for the DTS. Primary power sources (115/208 volts, 400 Hz, 3 phase; 20 volts dc; and 115 volts, 60 Hz, 1 phase) originate on the input connector plate and are routed through circuit breakers to the relay assembly. The front panel contains circuit breakers for all primary sources. All relay contacts are rated for 10 amperes. When the main power switch located on the control panel is OFF, only 28 volts dc is present at the output of the relay assembly. Distribution of power from the relay assembly is controlled by the logic circuits.

2.1.1.2 Power Supply

The power supply (see Figure 2-3) consists of four commercial power units furnishing +5 volt and +12 volt internal sources. The frame assembly is also a commercial unit designed for mounting the individual power units. The back panel has a 24-volt regulator for driving relays and a 15-volt regulator for excitation of the logic devices. The primary power source for the regulators on the back panel is 28 volts dc.

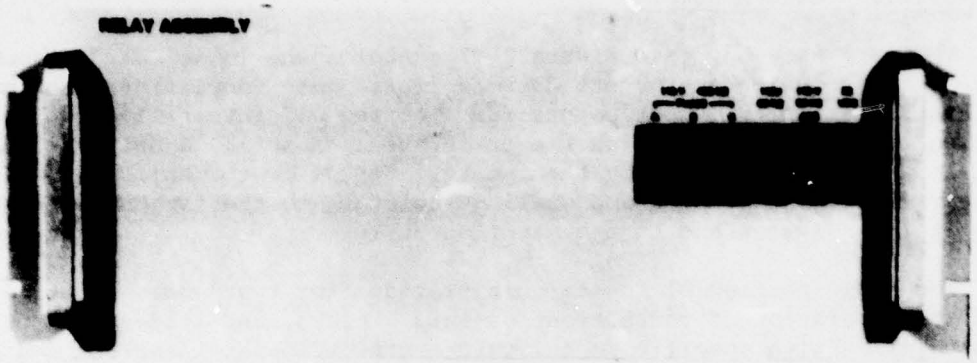

Figure 2-2. RELAY ASSEMBLY

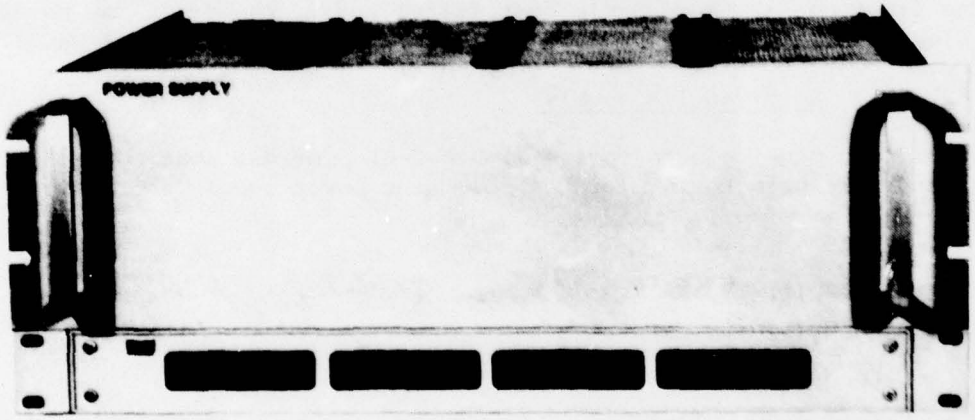

Figure 2-3. POWER SUPPLY ASSEMBLY

An integral blower assembly is provided for cooling the power supply.

2.1.1.3 Card Assembly

The card assembly (see Figure 2-4) contains the logic board assemblies, ac root mean square (ac-rms) to dc converters, meter amplifiers, and meter calibration circuits. Test points for checking all internally regulated voltage levels are provided on the calibration chassis. A built-in means of calibration is provided by the internal test selector switches, which connect reference voltages and scaling resistors to the various integrated circuit (IC) devices and to the metering devices.

The logic portion of the circuit provides for test mode selection and automatic operation of the current sensors, relays, and load-enable circuits in accordance with specific test requirements. Cabinet interlock and personnel safety interlock circuits are also provided by the logic. Provisions are included for expanding the capabilities of the DTS logic system to support additional types of low-voltage power supplies.

2.1.1.4 Blower Assembly

The blower assembly (see Figure 2-5) provides a commercial blower for cooling the cold plate assembly located in the test bench and for cooling the solid-state load assembly. Blower air is routed through the cold plate assembly and returned to the equipment rack assembly through ducting. The returned air is then routed through the load assembly and exhausted through the cabinet top into the room. Air enters through the grillwork located on the front panel. A reusable dust filter behind the grill may be detached for cleaning by releasing two thumb screws located on the front panel.

2.1.1.5 Load Panel Assembly

The load panel assembly (see Figure 2-6) provides load control, current, and voltage metering for the following power supply sections:

- 5-volt
- A-Load (+12 Volts)
- B-Load (+28 Volts)
- C-Load (-12 Volts)
- D-Load (-20 Volts)
- Short test

Each of these control sections contains panel meters for continuous monitoring of output voltages and currents from the unit under test (UTT). The control sections are arranged in load-banks and are provided with individual load-enable indicators. Only those banks applicable to the test mode selected are enabled. These control sections are described in the following paragraphs.

Figure 2-4. CARD ASSEMBLY

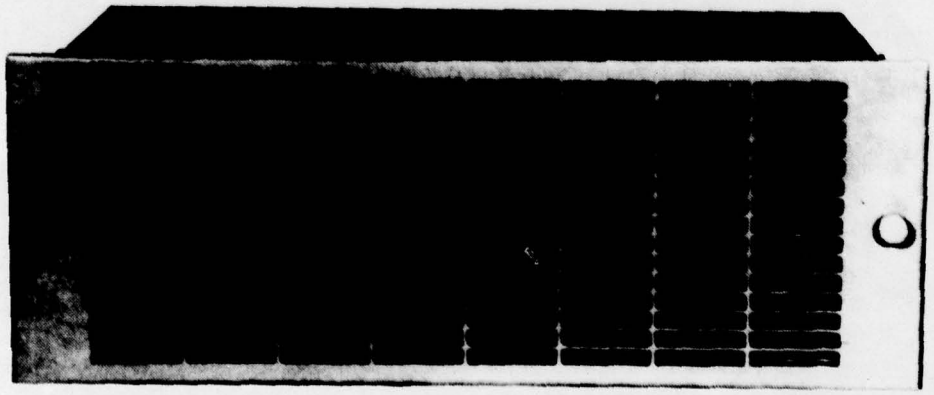

Figure 2-5. BLOWER ASSEMBLY

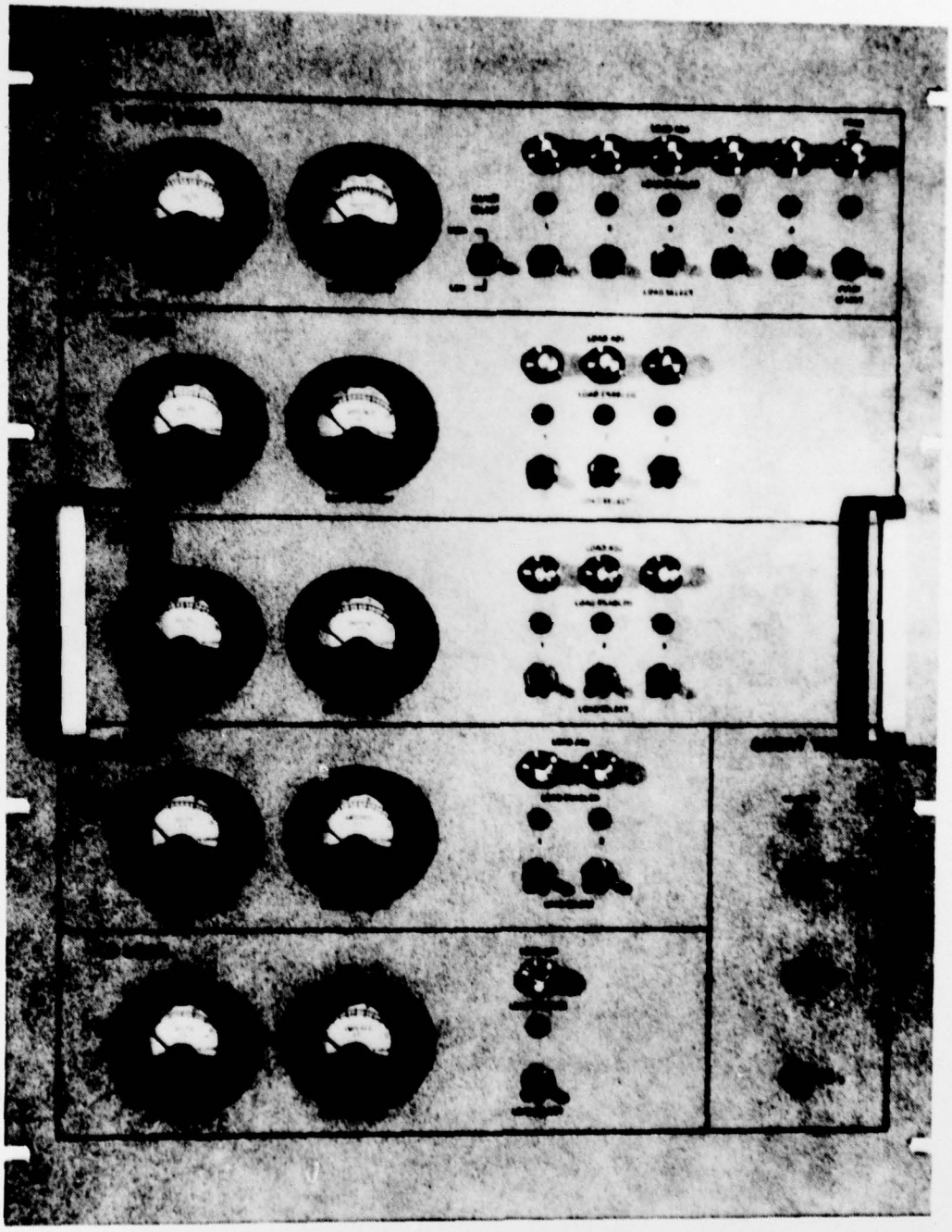

Figure 2-6. LOAD PANEL ASSEMBLY

5-Volt Load Section

The ammeter in the 5-volt load section is furnished with a low- or high-current range selector switch. In the low range, the meter is calibrated and scaled for 15 amperes full scale; in the high range, the meter is calibrated and scaled for 50 amperes full scale. Range selection does not interrupt current flowing in the load.

There are five load-bank selections, each of which is capable of load control sufficient to adjust the current from 0 to at least 10 amperes. Switches in each bank permit sequential application of preset load-current values. A 5-ampere pulse load circuit is also included in the 5-volt load section.

A-Load Section

The A-load section is applicable only to the +12 volt supply portion of the UUT. The voltmeter reads 15 volts full scale; the ammeter reads 15 amperes full scale. There are three load-bank circuits, each capable of adjusting the current from 0 to at least 4 amperes. Switches in each bank permit sequential application of preset load-current values.

B-Load Section

The B-load section is applicable only to the 28 volt portion of the UUT. The voltmeter reads 50 volts full scale; the ammeter reads 5 amperes full scale. There are three load-bank circuits, each capable of adjusting the load current from 0 to at least 2 amperes. Switches permit sequential application of preset current values.

C-Load Section

The C-load section is applicable only to the -12 volt portion of the UUT. The voltmeter reads 15 volts full scale; the ammeter reads 10 amperes full scale. There are two load-bank circuits, each capable of adjusting the current from 0 to at least 3 amperes. Switches permit sequential application of preset current values.

D-Load Section

The D-load section is applicable only to the 20 volt portion of the UUT. The voltmeter reads 30 volts full scale; the ammeter reads 1 ampere full scale. There is one load-bank control circuit that is capable of adjusting the current from 0 to at least 1 ampere. A switch permits application of a preset current value.

Short Test Section

The short test section consists of three instantaneous-type switches that activate relays and thereby short the output of the UUT. The shorting

operation is inhibited except during Test Mode 2 operation, in which the mode enable indicator is illuminated. The three shorting switches are applicable to the following power supply sections:

- 5-volt load
- A-load
- C-load

2.1.1.6 Line Monitor

Figure 2-7 illustrates the line monitor assembly, which houses panel meters that monitor the following functions:

- Phase voltage
- Neutral current
- Line current

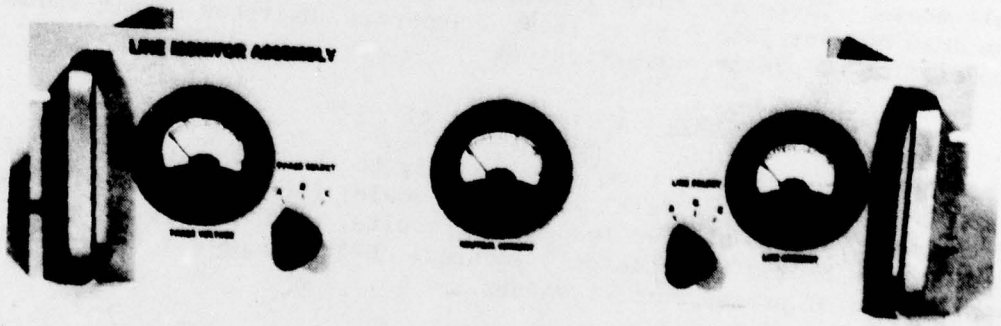

Figure 2-7. LINE MONITOR ASSEMBLY

The phase voltage meter measures the 400-Hz, 3-phase voltage applied to the UUT. The meter is connected ahead of the 400-Hz control relay to

permit monitoring of the input phase voltage at all times. A phase-select switch allows any one of the three phases to be selected for voltage monitoring. The voltage monitor reads 0 to 200 volts full scale.

The neutral current meter monitors the true rms neutral current portion of the 400-Hz, 3-phase line; it is scaled for 0 to 3 amperes.

To measure line current, current transformers sense the ac current and a true ac-rms to dc converter drives a meter. A switch permits any one of the three 400-Hz input lines to be selected for monitoring; selection does not interrupt the flow of current in the input lines. The meter is scaled for 0 to 3 amperes rms.

2.1.1.7 Calibration Assembly

The calibration assembly (see Figure 2-8) is mounted behind the panel marked "CALIBRATION". The calibration controls are accessible when the front panel is removed. They provide coarse adjustment of the solid-state load current, thereby establishing maximum limits for each load control.

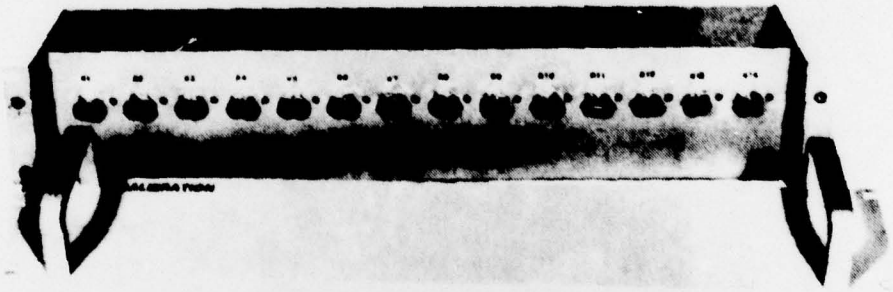

Figure 2-8. CALIBRATION ASSEMBLY

2.1.1.8 Load Assembly

The load assembly (see Figure 2-9) contains four heat sink assemblies for loading the power supply under test. One heat sink assembly contains a heat sink and Darlington transistors for loading the 5 volt portion of the UUT from 0 to 50 amperes and other Darlington transistors for loading the +12 volt portion from 0 to 6 amperes. Each Darlington transistor is capable of dissipating approximately 60 watts continuously.

Figure 2-9. LOAD ASSEMBLY

Another load assembly is similar to the first assembly except that the Darlington transistors furnish loads for the -12 volt, 28 volt, and -20 volt portions of the UUT. A 5-volt pulse load is included in this assembly. Drive signals for the Darlington transistors are developed in the load panel assembly.

Two additional heat sinks are installed in the load assembly for future use and provide an additional dissipation capability of 1,000 watts.

2.1.1.9 Transformer Chassis Assembly

The transformer chassis assembly contains a variable 3-phase transformer (VARIAC, Registered Trade Name of General Radio); a 3-phase, 400-Hz line transformer; and four current transformers to sense line current (see Figure 2-10).

2.1.2 Equipment Cabinet

The equipment cabinet assembly consists of the four assemblies listed below and are described in Subsections 2.1.2.1 through 2.1.2.4:

- Oscilloscope (scope) assembly
- Differential voltmeter (DVM) assembly
- Patch panel assembly
- Control panel assembly

2.1.2.1 Oscilloscope Assembly

The oscilloscope incorporated into the oscilloscope assembly (see Figure 2-11) is Model 465M, manufactured by Tektronix, Inc.

2.1.2.2 Differential Voltmeter Assembly

The differential voltmeter (DVM) incorporated into the differential voltmeter assembly (see Figure 2-12) is Model 893A, manufactured by John Fluke Company, Inc., and is equipped with a rack panel kit adapter. All precision measurements taken on the UUT use the DVM.

2.1.2.3 Patch Panel Assembly

The patch panel assembly (see Figure 2-13) contains test points to which the scope of DVM can be connected for measuring the output of the UUT. Cables connecting these points to the UUT are shielded and not load-bearing to permit precise voltage measurements.

2.1.2.4 Control Panel Assembly

The control panel (see Figure 2-14) contains pushbutton switches that control all DTS operations; indicator lamps that are integral with the

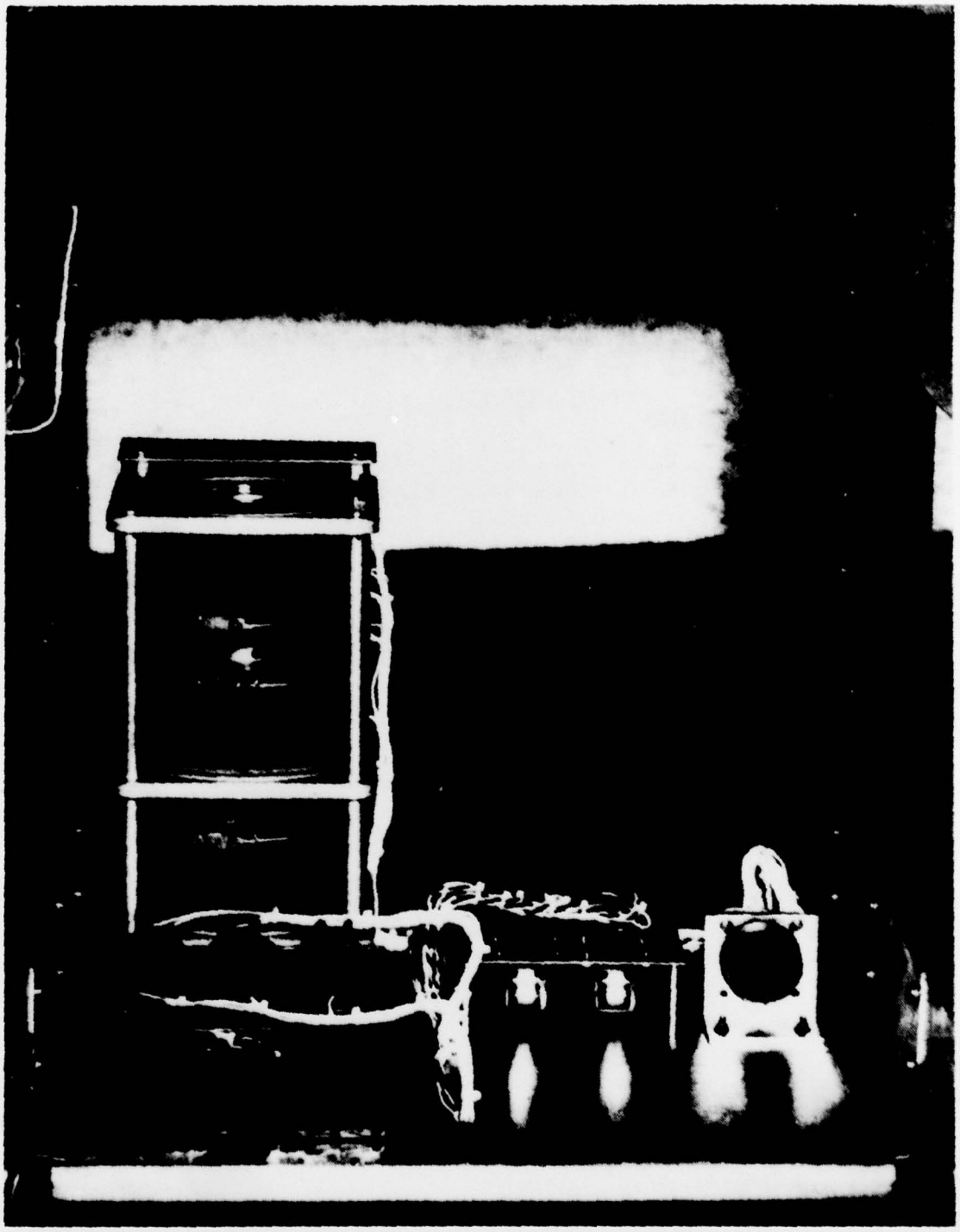

Figure 2-10. TRANSFORMER ASSEMBLY

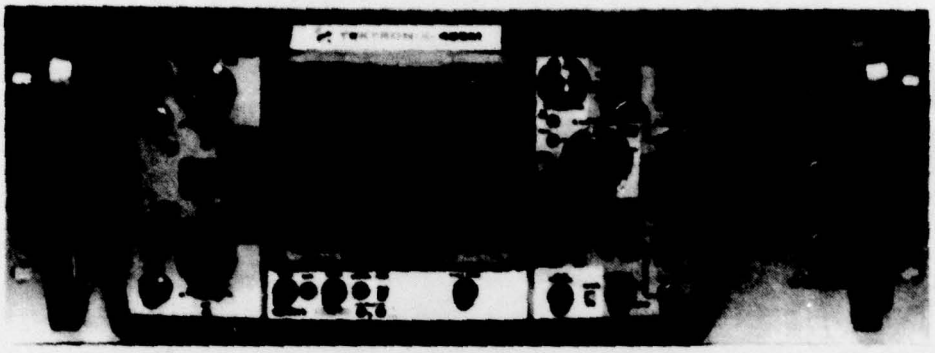

Figure 2-11. OSCILLOSCOPE PANEL

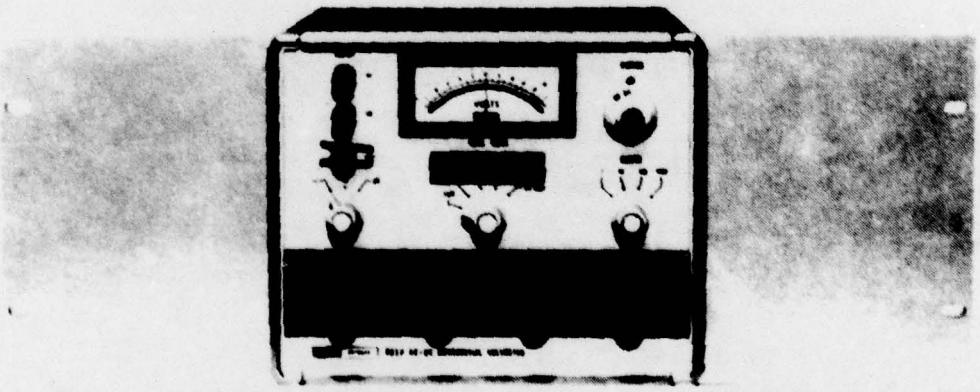

Figure 2-12. DIFFERENTIAL VOLTMETER PANEL

Figure 2-13. PATCH PANEL A2A2

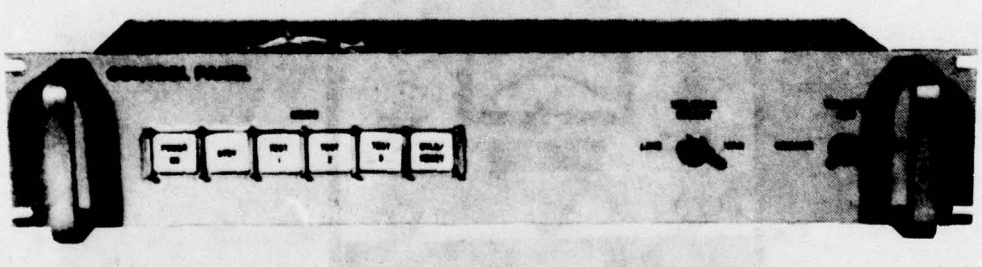

Figure 2-14. CONTROL PANEL A2A1

switches display the DTS operating mode. The ON/OFF switch serves as the main power switch: When the switch is in the OFF position, only 28 volts dc is available within the DTS in addition to the voltages at the relay assembly and the utility receptacles mounted in the test bench. When the switch is in the ON position, voltages are supplied to operate the internal power supplies and cooling fans. In this condition, no voltages except 28 volts dc and the voltage at the utility receptacles are available at the test bench or within the equipment rack assembly. When the standby (STBY) switch is depressed, ac voltages are applied to warm up equipment contained in the equipment rack, but no voltages are applied to the UUT. To operate the UUT, one of the three TEST buttons must be depressed to place the DTS in one of three available test modes. In the event of an overload, the DTS will automatically cycle to the overload (OVLD) mode of operation and announce this condition by a red illumination of the OVLD switch. In this condition, no voltage is applied to the UUT, and the DTS operation may be restored to STBY by depressing the OVLD switch.

2.1.3 Test Bench

The test bench (see Figure 2-1) consists of an air-cooled cold plate, control panel/junction box, storage drawers, and indicator lamps related to the UUT. Dogging assemblies are provided for attaching the UUT and subassemblies (when removed from the main chassis) to the cold plate. The accessory cables and jig assemblies also can be attached to the cold plate. Controls mounted on the test bench are essentially related to testing of the UUT. The cold plate contains safety interlock switches that permit DTS operation only when safety hoods, which shield the operator from exposure to hazardous voltage, are properly installed.

2.1.4 Accessory Jigs, Fixtures, and Test Cables

Accessory test jigs, fixtures, and test cables required to test the power supplies are illustrated in Figure 2-15.

2.2 SAFETY INFORMATION

The DTS incorporates many safety features that protect the operator from exposure to voltages that could result in injury or death.

When the DTS is operated in the OFF mode, high-voltage excitation is limited to the input junction box (mating internal wiring with the 115/208-volt, 400-Hz, 3-phase external lines), the relay assembly, and the accessory utility receptacles. The relay assembly and input junction boxes are covered to prevent exposure to the operator. Access panels and equipment doors are electrically interlocked to safeguard personnel from exposure to high voltage. The safest means of performing maintenance on the DTS is to disconnect all external power cables located on the left side near the rear of the equipment rack assembly.

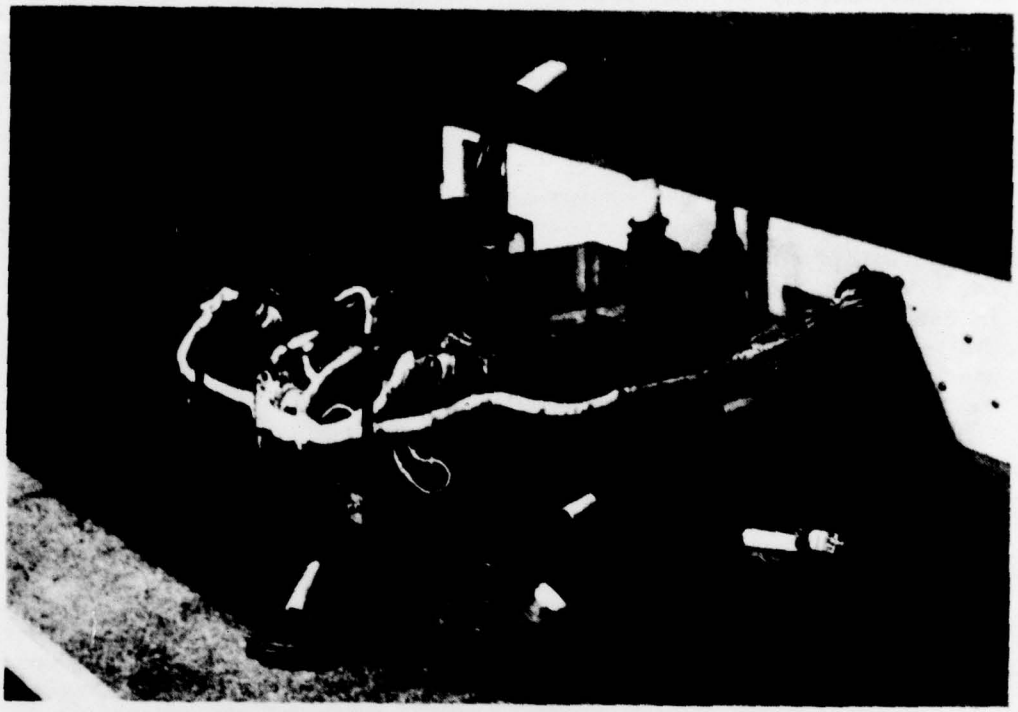

Figure 2-15. ACCESSORY JIGS, FIXTURES, AND TEST CABLES

Transparent hoods covering the UUT are provided to protect the operator from exposure to the 115/208 volts. A safety interlock that prevents application of high voltage to the UUT if the hoods are removed is incorporated into the logic circuits. A safety override switch located on the test bench panel can be used to defeat this function since some equipment measurements may require removal of the protective hoods. When this safety override is used, a large red indicator located on the test panel portion of the bench is illuminated.

CHAPTER THREE

DOCUMENTATION

This chapter presents the documentation developed to support the utilization of the Dynamic Test Facility (DTF). In addition, contractual data items that were specifically required are described.

3.1 DYNAMIC TEST FACILITY

The total DTF consists of the following equipment and material:

- The Dynamic Test Set (DTS)
- The DTF Operating Manual
- Supplement A - TP100, Test Procedure for Power Supply 624R629G01
- Supplement B - TP200, Test Procedure for Power Supply 634R149G01
- Supplement C - TP300 Calibration Procedure for the DTS
- Supplement D - TP400 Maintenance for the DTS
- Supplement E - Commercial Manuals for Internal Power Supplies, Oscilloscope, and Differential Voltmeter

As part of this contractual task, a comprehensive Operating Manual was developed and delivered to WR-ALC. This manual describes the DTF and the test philosophy for the AN/ALQ-119(V) power supply. It also presents the theory of operation and the installation, removal, and assembly/disassembly instructions for the DTS.

3.2 CONTRACT ITEMS

The following contractual items refer to the specific items delineated in Air Force Contract F09603-78-G-4125-0002, and their delivery as part of this contract is as noted.

3.2.1 Dynamic Test Set

The Dynamic Test Set was designed, fabricated, and tested as required by the contract. The DTS was demonstrated to Mr. Dave Williams and Mr.

James Defore (WR-ALC) on 25-27 June 1979 at ARINC Research Headquarters. The DTS was delivered to the Warner Robins Technology Repair Center on 12 July 1979, where it was installed and demonstrated on a laboratory standard power supply.

3.2.2 Data Items

The following contractual data items were delivered to WR-ALC:

- A001 Drawings (Engineering and Associated Lists)
  - •• Engineering drawings were delivered on 30 July 1979.
  - •• The Master Engineering Document Member List was delivered 30 July 1979.
- A002 Service Engineering Reports
  - •• Monthly Status Letters were delivered each month as required.
  - •• The Final Report is herein delivered.
- A003 Equipment Test Plan. The Equipment Test Plan was delivered and approved by WR-ALC. This plan was used as the basis for the Qualification Test Plan to test the DTS.
- A004 Nonstandard Parts Approval Requests (NSPAR). Whenever possible, the DTS uses standard parts. Some parts could not be located as standard parts nor could substitutes be found. For these parts, NSPARs were prepared and submitted to WR-ALC for approval. Those approved items are listed in the April 1979 Status Letter.
- A005 Hazard Analysis Report. The test set was designed so that it will not present a hazard to personnel using it as long as it is used according to the instructions contained in the Operator's Manual. Therefore, Hazard Analysis Reports were not required to be submitted.
- A006 Technical Publications for Advanced Development Program. As applied to this project, this item is a Dynamic Test Set Operating Manual, which was delivered to WR-ALC.

3.2.3 Other Data Items

The following data items were delivered to WR-ALC:

- Test procedure TP100 for Power Supply No. 624R629G01
- Test procedure TP200 for Power Supply No. 634R149G01
- Calibration procedure TP300 for the Dynamic Test Set
- Maintenance procedure TP400 for the Dynamic Test Set
- Qualification Test Procedure for the Dynamic Test Set

CHAPTER FOUR

RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

4.1 RESULTS

The Dynamic Test Facility ordered under Air Force Contract F09603-G-4125-0002 has been delivered, installed, and is in operation at the Technical Repair Center (TRC) at the Warner Robins Air Logistics Center (WR-ALC), Robins Air Force Base, Georgia.

4.2 CONCLUSIONS

On the basis of the successful implementation and demonstration of the DTS at WR-ALC, ARINC Research concludes that this test facility will adequately provide the test equipment support requirements for the AN/ACQ-119 low-voltage power supplies.

4.3 RECOMMENDATIONS

On the basis of the results of the project efforts, ARINC Research makes the following recommendations:

- Spare-parts provisioning should be acquired by the Air Force to ensure maximum utilization of the DTS.
- Consideration should be given to the preparation of a formal Technical Order (T.O.) for the DTS to enhance utilization by Air Force personnel.
- The DTS was developed with a reserved growth capability of 1,000 watts power dissipation. This growth capability was included in anticipation of the AN/ALQ-131 ECM pod transition to WR-ALC support. Since this transition is currently being implemented, the DTS should be modified to operate with the AN/ALQ-131 ECM pod low-voltage power supplies.
- Other power supplies under TRC cognizance may benefit from the capability demonstrated by the DTS. Wherever possible, this "controlled full-operational-load" technique should be investigated for application to other programs within the TRC.